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(54) High-frequency thrombectomy catheter

(57) This invention relates to a catheter comprising a tube-like basic body with a proximal and a distal end and a high-frequency generator associated with the catheter used for the purpose of generating high-frequency mechanical vibrations at the distal end of the catheter. The catheter comprises a lumen to be filled with liquid which is connected at the proximal end to an area inside of which a high-frequency moveable member of the high-frequency generator is located and wherein at the distal end of the catheter guiding means have been arranged for deflecting high frequency longitudinal waves travelling through the liquid inside the lumen in a lateral direction.

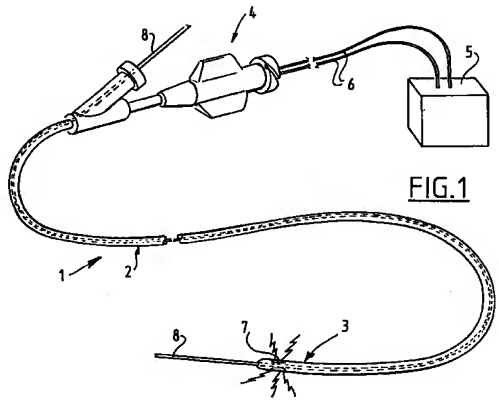

FIG.1

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Description

The invention relates to a catheter used to remove thrombi from the blood vessels of a patient.

The catheter according to the invention comprises a tube-like basic body with a proximal and a distal end and a high-frequency generator to be used together with the catheter for the purpose of generating high-frequency mechanical vibrations at the distal end of the catheter.

The high-frequency mechanical vibrations generated by the high-frequency generator produce high-frequency longitudinal waves in the blood. These waves are absorbed by the thrombi which fall apart as a result. The particles of thrombi thus formed can be removed by means of a suction catheter for instance.

A very suitable embodiment of the catheter according to the invention is characterised in claim 2. The lumen is filled with a saline-solution or blood, so that the mechanical vibrations generated by the high-frequency generator are propagated in the form of longitudinal waves to the distal end. The conducting means ensure that the high-frequency waves are aimed at the thrombi in order to fragment them.

A very suitable embodiment is additionally characterised in claim 3. The cone-shaped mirror ensures that waves being propagated in the longitudinal direction of the catheter are deflected transversely at the distal end in order to be able to act on thrombi et cetera attached to the walls of the blood vessel.

With the measure as set out in claim 4 it is achieved that all around the distal end a uniform distribution of the high-frequency energy is effected.

Another suitable embodiment is characterised in claim 5. The high-frequency mechanical vibrations are in that case generated in the immediate vicinity of the location where they are to be utilized.

At a suitable location the excitable element is additionally a piezo-electric element. The required frequencies can be generated so as to have sufficient power using an element of limited size.

A very suitable further development of the catheter according to the invention is characterised in claim 7. The fragmented thrombi can be removed from the body of the patient directly via the suction inlet through the discharge lumen.

Additionally, the measure as set out in claim 8 is preferably employed. It should be noted that catheters using suction generated by ejector action are known as such, for instance from the European patent 0 442 579.

In order to adjust the shock waves to the diameter of the blood vessel, the distance to the wall of the blood vessel and the size and condition of the thrombus to be fragmented, the measure as set out in claim 9 is preferably employed. When being used, the frequency is set by means of the frequency-adjusting-element in such a way that maximal absorption of energy inside the thrombus is realised.

The invention will be explained in greater detail in the following description with reference to the attached drawings.

Figure 1 shows schematically a catheter according to the invention.

Figure 2 shows the distal end-section of a preferred embodiment of the catheter according to the invention.

Figure 3 illustrates a further developed embodiment of the catheter according to the invention in a position of use.

Figure 4 shows an end-section of yet another embodiment.

Figure 5 shows a view substantially corresponding to figure 4 of a further developed embodiment of the catheter according to the invention.

The catheter 1 illustrated in figure 1 comprises a tube-like basic body 2 with a distal end 3 and a proximal end 4. When in use the catheter 1 is introduced into a patient with the distal end. For this purpose a guide wire 8 can be used. The catheter 1 is passed with a lumen over the guide wire 8, until the distal end 3 has reached the desired position.

A high-frequency generator 5 is used together with the catheter 1. With the embodiment shown in figure 1, this high-frequency generator 5 is a substantially independent unit which can propagate high-frequency mechanical vibrations by means of lines 6 to the distal end 3 of the catheter 1. For this purpose there is a lumen inside the basic body 2 of the catheter 1 which is filled with a liquid when the catheter is used, which may be for instance a saline solution but also blood of the patient. With this embodiment the lines 6 may be tube-like lines, whereby a channel of these lines 6 is connected with the lumen referred to. The liquid is in that case also present in the lines 6.

The high-frequency generator 5 comprises a high-frequency moveable member which is connected to the liquid inside the lines 6 and the above mentioned lumen of the basic body 2. This high-frequency moveable member generates high-frequency longitudinal waves which are propagated through the liquid inside the lumen and through a window 7 at the distal end 3 of the catheter 1. These high-frequency longitudinal waves act on thrombi located at the distal end 3. These thrombi absorb the vibration-energy as a result of which they disintegrate. The thrombi thus fragmented can be removed by means of a suction catheter for instance.

Apart from the end-section illustrated in figure 2, the catheter 10 as shown in figure 2 corresponds to the catheter 1 of figure 1. The high-frequency longitudinal waves are propagated through the lumen 11. Guiding means have been arranged at the distal end in the shape of a substantially cone-shaped mirror 16 diverging in the distal direction. The latter ensures that the high-frequency waves are deflected in a lateral direction, so that thrombi located at the side of the distal end

10 can be acted on.

With the example of an embodiment shown, the mirror 16 has been connected with an inner tube-like element 13 of the catheter which extends through the lumen 11. At the distal end this inner tube-like element has been connected with the outer tube-like element in a manner not described here, so that a fixed coaxial position of the inner tube-like element 13 inside the lumen 11 is obtained.

A lumen 14 extends through the inner tube-like element which is associated with a guide wire 15.

With the catheter 20 of figure 3 the high-frequency energy is also supplied via a central lumen 23 inside the basic body 22. The high-frequency waves are also in this case deflected in a lateral direction by a cone-shaped mirror 27, so that they can act on thrombi 28 or other deposits on the wall of a blood vessel 21 shown in figure 3.

Due to the action of the high-frequency waves, which may be of a continuous or pulsatory nature, the deposit 28 is fragmented. The catheter 20 has been provided with a discharge lumen 25 through which the fragments 29, which have come off the deposit 28, can be removed. For this purpose the catheter 20 has additionally been provided with a pressure lumen 26 through which liquid under high pressure can be supplied. The pressure lumen 26 opens into a jet nozzle 31 which directs a jet, past the suction inlet 30 in the discharge lumen 25, towards the inside. Because of this, due to ejector action, suction will be created in the suction inlet 30 as a result of which the loosened fragments 29 will be sucked in. Because of the action of the jet produced by the jet nozzle 31, these fragments 29 are additionally reduced further in size so that they can be removed easily via the discharge lumen 25.

The catheters 40 and 50 as shown in the figures 4 and 5 respectively, comprise an integrated high-frequency generator instead of an external high-frequency generator. The high-frequency generator 42 of the catheter 40 is a piezo-electric element which is excited by means of electrical excitation lines 43 which extend from the proximal end through the basic body 41 to the high-frequency generator 42. By means of suitable excitation via the lines 43 the high-frequency generator 42 will start to vibrate mechanically as a result of which high-frequency waves are formed which are immediately passed on to the surrounding liquid, in particular blood. The blood will transmit the high-frequency waves to the thrombi to be fragmented.

As has been illustrated with the catheter 40, a central lumen 44 has been arranged which is associated with a guide wire 45.

The catheter 50 of figure 5 has also been provided with a high-frequency generator 52 integrated in the distal end of the catheter, comprising preferably a piezo-electric element. The excitation lines 53 for the high-frequency generator 52 extend through the basic body 51.

Inside the basic body 51 a suction lumen 56 has been arranged as well, which is accessible via an opening 57 in the wall of the basic body 51. Via a pressure line 58 liquid under high pressure is supplied which directs, in a manner analogous to the one described in relation to figure 3, a liquid jet past the opening 57 towards the suction lumen 56 in order to suck fragmented thrombi et cetera through the opening 57 and discharge them via the lumen 56. The catheter 50 is advanced in the manner described above to the intended position inside the body of the patient by means of a guide wire 55 extending through a lumen 54.

Claims

1. Catheter comprising a tube-like basic body with a proximal and a distal end and a high-frequency generator associated with the catheter used for the purpose of generating high-frequency mechanical vibrations at the distal end of the catheter.

2. Catheter as claimed in claim 1, wherein the catheter comprises a lumen to be filled with a liquid, which is connected at the proximal end to an area inside of which a high-frequency moveable member of the high-frequency generator is located and wherein at the distal end of the catheter guiding means have been arranged for deflecting high-frequency longitudinal waves travelling through the liquid inside the lumen in a lateral direction.

3. Catheter as claimed in claim 2, wherein the guiding means comprise a substantially cone-shaped mirror diverging in the distal direction.

4. Catheter as claimed in claim 3, wherein the substantially cone-shaped mirror has been arranged coaxially with the lumen.

5. Catheter as claimed in claim 1, wherein the high-frequency generator comprises an element excitable by means of electrical vibrations at the distal end and electrical excitation lines extend from the proximal end, through the basic body, to the element.

6. Catheter as claimed in claim 5, wherein the excitable element is a piezo-electric element.

7. Catheter as claimed in one of the previous claims, comprising at the distal end of the catheter a suction inlet connected with a discharge lumen in the basic body.

8. Catheter as claimed in claim 7, wherein the basic body furthermore comprises a pressure lumen which is connected to a jet nozzle directed in a proximal direction past the suction inlet used for the purpose of generating suction by means of ejector action.

9. Catheter as claimed in one of the previous claims, wherein the high-frequency generator comprises a frequency- adjusting-element.

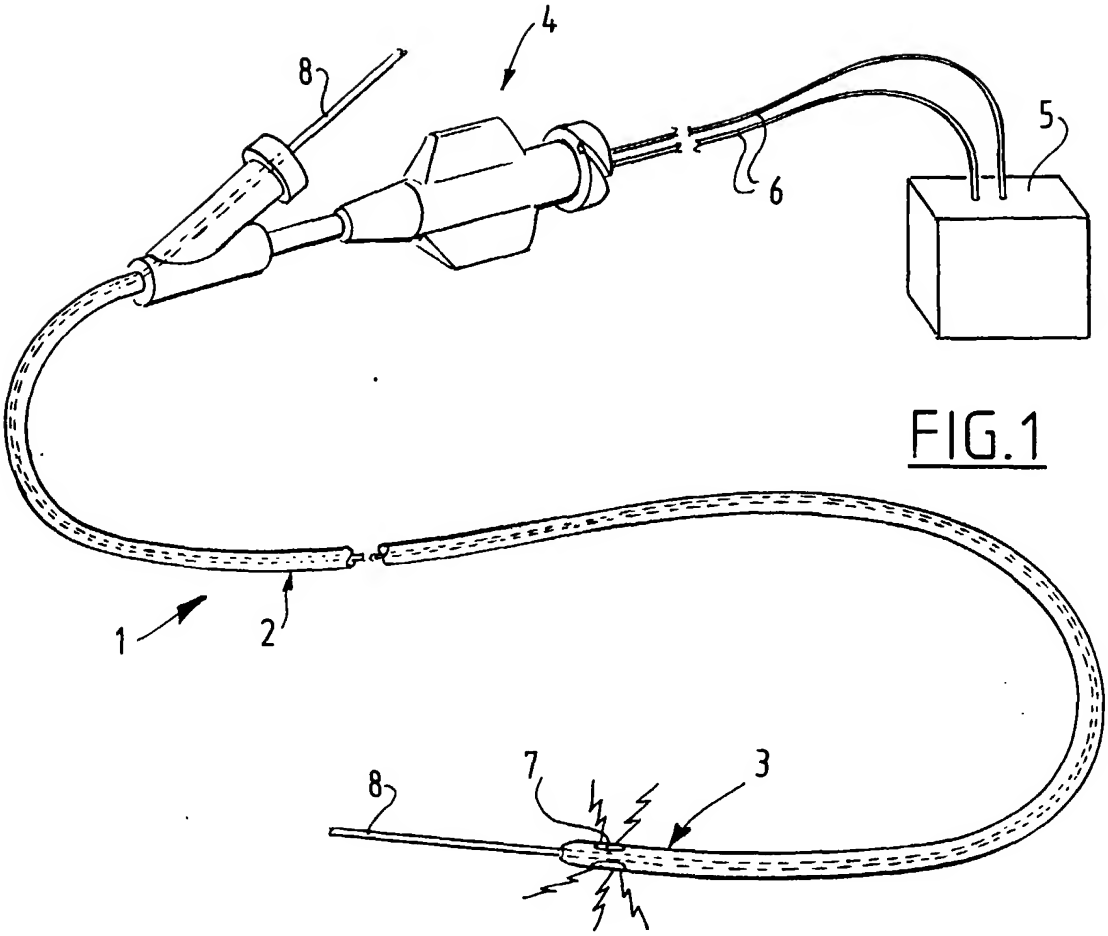

FIG.1

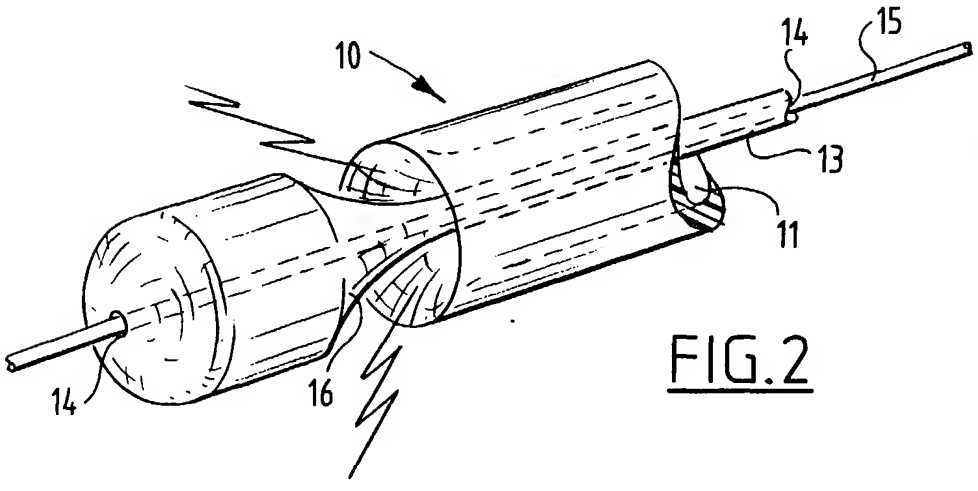

FIG.2

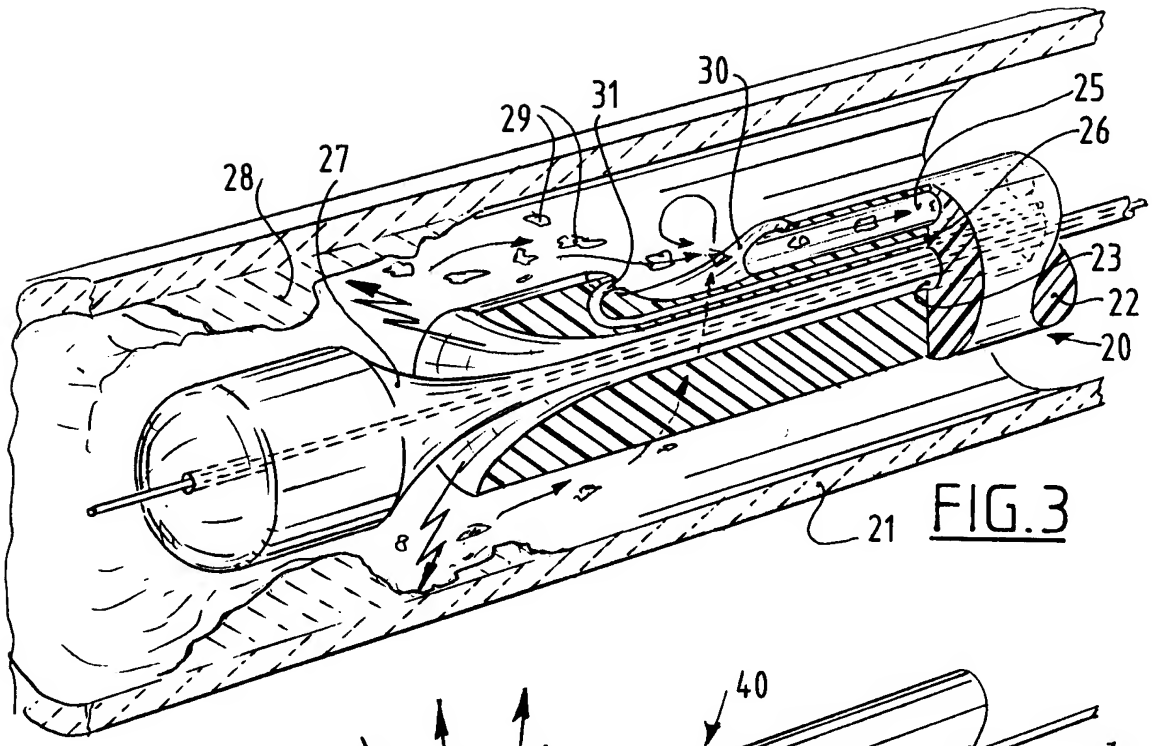

FIG.3

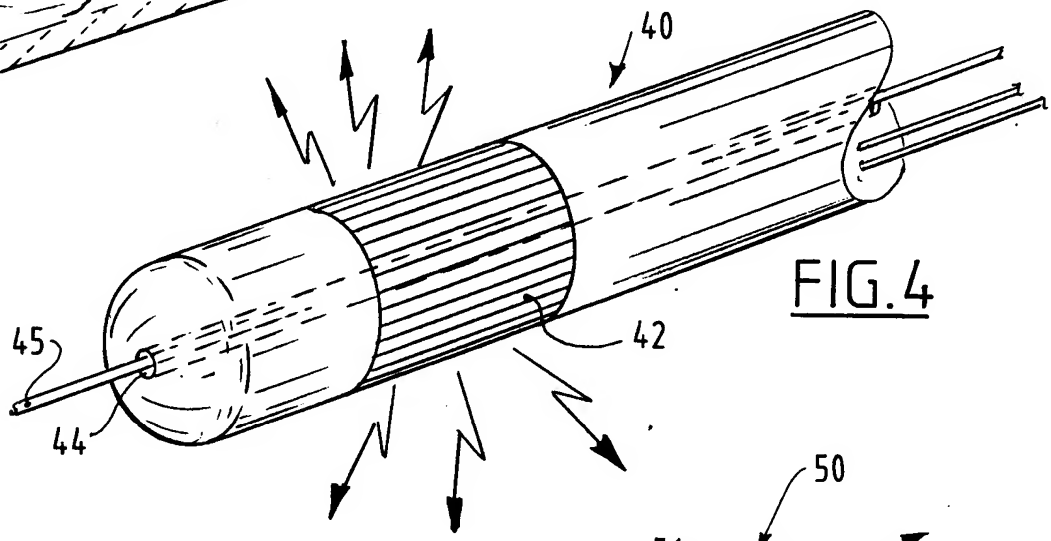

FIG.4

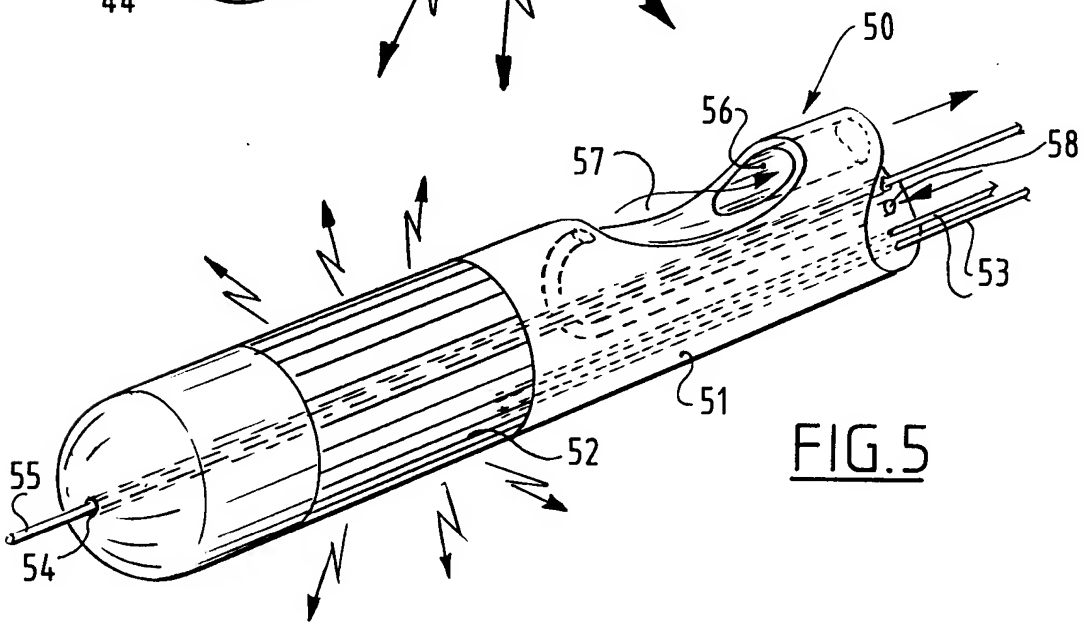

FIG.5

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 97 20 0308

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 380 273 A (DUBRUL) 10 January 1995 * the whole document *	1,2,5,6, 9	A61B17/22
X	DE 38 12 841 A (SCHUBERT) 2 November 1989 * page 1, line 29 - page 2, line 36; figures *	1,2	
X	US 4 808 153 A (PARISI) 28 February 1989 * column 2, line 29 - column 3, line 17; figures *	1,5,6	
A	EP 0 232 678 A (NERACHER) 19 August 1987 * abstract; figures *	3,4	
A	EP 0 378 691 A (SUMITOMO) 25 July 1990 * claims 1,2; figures *	5,6	
D,A	EP 0 442 579 A (CORDIS) 21 August 1991 * abstract; figure 7 *	7,8	
P,X	WO 96 08196 A (SOLAR) * page 6, line 1 - page 7, line 16; figures *	1,5	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A61B
A61M

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	7 April 1997	Kousouretas, I

CATEGORY OF CITED DOCUMENTS

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